Mandibular Thickness Measurements in Young Dentate Adults

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Objective: To measure thicknesses in clinical landmark areas of the dentate mandibles of young men and women.

Design: Using standard radiologic software, we obtained mean (SD) thickness measurements at the inferior or posterior borders of the mandible at the following 7 surgically useful sites: (1) the symphysis, (2) a point halfway between the symphysis and the mental nerve, (3) the mental nerve, (4) a point halfway between the mental nerve and the facial artery notch, (5) the facial artery notch, (6) the angle vertex, and (7) the ramus–condylar neck border.

Setting: University hospital.

Patients: A total of 150 dentate men and 75 dentate women aged 18 to 30 years who had undergone computed tomography of the head and neck region during the period of December 20, 2006 to February 20, 2007.

Main Outcome Measure: Thicknesses of 7 mandibular sites.

Results: Mean (SD) thicknesses at the 7 mandibular sites were as follows: symphysis, 14.03 (1.53) mm for men and 13.21 (1.46) mm for women; halfway between the symphysis and the mental nerve, 11.17 (1.37) mm for men and 10.00 (1.08) mm for women; mental nerve, 9.48 (1.28) mm for men and 8.72 (1.00) mm for women; halfway between the mental nerve and the facial artery notch, 10.33 (1.24) mm for men and 9.45 (0.92) mm for women; facial artery notch, 7.27 (0.82) mm for men and 7.10 (0.88) mm for women; angle vertex, 5.42 (0.90) mm for men and 5.39 (0.66) mm for women; and ramus–condylar neck border, 5.90 (0.86) mm for men and 5.85 (0.71) mm for women.

Conclusions: Clinical landmark areas in young dentate mandibles have mean thicknesses with limited SDs. The thickness measurements obtained at the sites in this study provide practical reference information for mandibular reconstruction and bicortical screw length estimation.

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conducted through computed tomography (CT) in 150 men and 75 women. Such measurements can be used to speed mandibular reconstructions, especially in the high-volume facial trauma setting, through extrapolation of the data to provide guidelines for bicortical screw sizing during rigid fixation of fractures, thereby reducing the need for depth gauge measurements.

**METHODS**

A radiologic anatomical study was conducted in random dentate 18- to 30-year-old patients who had undergone CT of the head and neck region from the Health Insurance Portability and Accountability Act–compliant radiologic network at the University of Maryland Medical Center from December 20, 2006 to February 20, 2007. Individuals were excluded from the study if they had mandibular or other head or neck trauma, cancer, bone disease, tooth loss, or growth abnormalities. A total of 225 individuals (150 men and 75 women) were analyzed. Study participants were segregated by sex only, and mandibular thickness was measured using standard radiologic viewing software (AquariusNET Viewer; TeraRecon Inc, San Mateo, California). Specifically, thickness measurements were obtained at the inferior and posterior borders of the mandible at the following sites: (1) the symphysis, (2) a point halfway between the symphysis and the mental nerve, (3) the mental nerve, (4) a point halfway between the mental nerve and the facial artery (antegonial) notch, (5) the facial artery (antegonial) notch, (6) the angle vertex (gonion), and (7) the ramus-condylar neck border (Figure 1). Particular attention was given to the measurement of the mandibular thickness at a point where a titanium fixation plate would typically be secured (along the buccal cortex of the inferior or posterior borders of the mandible). Cross-sections of the mandible in customized axial, coronal, and sagittal views were identified with the viewing software, and a digital ruler was oriented perpendicular to the buccal cortex to measure the horizontal thickness of the mandible along the same path for bicortical screw placement (Figure 2). To eliminate variability among study participants, only 1 side of the mandible in each individual was measured. This study was approved by the institutional review board of the University of Maryland.

**RESULTS**

Measurements in mandibles from 150 men and 75 women were obtained by the use of CT software. The means (SDs) for the 7 measured locations are given in Table 1. Each adjacent site exhibited differences that were statistically significant \((P < .001)\) based on the unpaired \(t\) test. At each of the anatomical positions, women had smaller thicknesses compared with men. In both men and women, the regions of the symphysis and anterior mandible were thicker than the posterior mandible. The angle vertex (gonion) was the thinnest portion of the mandible in both men and women. The region below the mental nerve foramen was slightly thinner than the points proximal and distal to it.

**COMMENT**

Knowledge of mandibular thickness measurements can be used as a practical reference for a number of applications,
including mandibular fracture repair, mandibular reconstruction, and the understanding of mandibular anatomy in general. The mandibular thickness data obtained in this study follow closely the predictions made possible by gross anatomical and clinical experience, although no such data have been reported in the literature to our knowledge. Anatomical position 3 (the location below the mental nerve) was found to be thinner than position 4 located proximal to it, contrary to any assumption that the thickness of the mandible tapers uniformly in thickness from distal to proximal (Figure 3). In the posterior body, the oblique and mylohyoid lines and the presence of molar roots create the increased thickness between the mental nerve region and the facial artery notch. In the anterior body, the thinner bone beneath the mental nerve may contribute to the large propensity for mandible fractures to occur near the mental foramen, independent of the presence of the mental foramen itself. Indeed, the largest percentage of mandibular fractures, nearly one-third, occur in the body of the ramen itself. Indeed, the largest percentage of mandibular fractures, nearly one-third, occur in the body of the mandibular ramus, independent of the presence of the mental foramen, which is seemingly needless based on its negligible benefit toward fixation outcome according to the experience of one of us (T.T.L.) with the use of a 2-plate rigid fixation technique with locking plates. The relatively consistent screw sizes predicted by the anatomical averages described herein provide an appealing time-saving substitute for depth gauge measurements. Although surgeons may choose to estimate bicortical screw size through a number of methods (eg, anatomical averages, experience-based estimates, preoperative CT measurements, metered drill bits, or depth gauge), ultimately, sound plating techniques and ample mandibular bone stock for screw engagement are much more important factors in proper fracture fixation than the method of screw size estimation.

Table 1. Mandibular Thicknesses in Study Participants

<table>
<thead>
<tr>
<th>Anatomical Position</th>
<th>Mean (SD) Mandibular Thickness, mm</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Men (n=150)</td>
</tr>
<tr>
<td>1</td>
<td>14.03 (1.53)</td>
</tr>
<tr>
<td>2</td>
<td>11.17 (1.37)</td>
</tr>
<tr>
<td>3</td>
<td>9.48 (1.28)</td>
</tr>
<tr>
<td>4</td>
<td>10.33 (1.24)</td>
</tr>
<tr>
<td>5</td>
<td>5.72 (0.82)</td>
</tr>
<tr>
<td>6</td>
<td>5.42 (0.90)</td>
</tr>
<tr>
<td>7</td>
<td>5.90 (0.86)</td>
</tr>
</tbody>
</table>

Figure 3. Mandibular thickness data for men and women at the 7 anatomical positions. Error bars indicate 1 SD.

Table 2. Suggested Bicortical Screw Lengths for Mandibular Internal Fixation in Men and Women, With the Assumption of Titanium Plates of 1.5-mm Profile Height

<table>
<thead>
<tr>
<th>Anatomical Position</th>
<th>Suggested Screw Length, mm</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
</tr>
<tr>
<td>1</td>
<td>16-18</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
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<tr>
<td>4</td>
<td>12</td>
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<td>5</td>
<td>10</td>
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<tr>
<td>6</td>
<td>8</td>
</tr>
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<td>7</td>
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</table>

The mandibular thickness measurements can also be added to the profile height of titanium plates to predict the approximate screw length necessary for bicortical screw placement, thereby reducing the need for depth gauge measurements. Commonly used mandibular fracture plates intended to hold bicortical screws have profile heights of approximately 1.5 mm. One SD above the mean value statistically accounts for the upper 84th percentile of the gaussian distribution of mandibular thicknesses at each anatomical position. Meanwhile, most mandibular fixation hardware systems have screws with even-integer millimeter sizes only. With these considerations in mind, a suggested screw-size reference table can be constructed that would account for most mandibular thicknesses and the overlying titanium plate, with the assumption of proper drilling angle, plate bending, and negligible subplate dead space (Table 2).

The suggested screw lengths serve as guidelines only and are not applicable in all mandibular situations, especially if oblique drilling angles and major anatomical variations necessitate formal measurement with a depth gauge. In determination of the suggested screw size at each site, it is better to oversize rather than undersize a screw length to ensure bicortical engagement. Even if a screw is undersized, monocortical screw placement has been suggested clinically in some situations to be as stable as bicortical screw placement, although the senior author (T.T.L.) adheres to the principles of rigid fixation and the security of bicortical screws.

Many experienced mandibular surgeons have developed an intimate knowledge of mandibular thicknesses and necessary screw sizes through clinical practice and hence use a depth gauge infrequently. Therefore, the current study serves to corroborate the real-life clinical observations of these surgeons. For example, one of us (T.T.L.) has achieved good clinical outcomes in more than 300 mandibular fracture fixations, with the estimation of bicortical screw size primarily through prior knowledge of screw size at the fracture location and the reservation of the depth gauge only for instances that involve aberrations of normal intracortical thickness (eg, oblique fractures or lag screwing). Although a depth gauge provides a true measurement for bicortical screw sizing, its routine use can be cumbersome in the high-volume facial trauma setting and is seemingly needless based on its negligible benefit toward fixation outcome according to the experience of one of us (T.T.L.) with the use of a 2-plate rigid fixation technique with locking plates. The relatively consistent screw sizes predicted by the anatomical averages described herein provide an appealing time-saving substitute for depth gauge measurements. Although surgeons may choose to estimate bicortical screw size through a number of methods (eg, anatomical averages, experience-based estimates, preoperative CT measurements, metered drill bits, or depth gauge), ultimately, sound plating techniques and ample mandibular bone stock for screw engagement are much more important factors in proper fracture fixation than the method of screw size estimation.
tion. Future studies that describe the accuracy of alternative screw size estimation techniques relative to speed of surgery and long-term fixation outcomes may be warranted.

Limitations of this study stem from the fact that the data represent measurements made in a “virtual” digital setting rather than in cadaveric or live gross specimens, and hence no physical measurements exist to validate the digital data obtained in this study. Cadaveric specimens from young adults are limited in number because most gross anatomical cadaver laboratories have specimens from older individuals. Meanwhile, amassing gross measurements in live, healthy, noninjured mandibles would be impractical and likely unethical. A possible validating study could involve the large-scale compilation of depth gauge measurements during mandible fracture repairs to attain ample data for the proposed anatomical sites. However, fracture abnormalities at the area of measurement could distort bicortical thickness measurements. Future large-scale radiologic anatomical studies may add additional information in regard to differences in mandibular thickness and anatomy among age groups or races.

In conclusion, commonly encountered clinical landmarks in the dentate mandibles of young men and women have mean thicknesses with limited SDs. The thickness measurements obtained at the sites in this study provide practical reference information for mandibular reconstruction. By the addition of the thickness of titanium plate to the measurement of the average mandibular thickness at each site, guidelines for bicortical screw sizing can be established that can obviate a procedural step in plate fixation.

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Author Contributions: Both authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Le. Acquisition of data: Beaty. Analysis and interpretation of data: Beaty and Le. Drafting of the manuscript: Beaty. Critical revision of the manuscript for important intellectual content: Le. Statistical analysis: Beaty. Administrative, technical, and material support: Beaty. Study supervision: Le.

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REFERENCES